



Extending NASA Research Results to Benefit Society: Rapid Prototyping for Coastal Applications

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ABSTRACT

The mission of the NASA Applied Sciences Program is to expand and accelerate the use of NASA research results to benefit society in 12 application areas of national priority. One of the program's major challenges is to perform a quick, efficient, and detailed review (i.e., prototyping) of the large number of combinations of NASA observations and results from Earth system models that may be used by a wide range of decision support tools. A Rapid Prototyping Capacity (RPC) is being developed to accelerate the use of NASA research results. Here, we present the conceptual framework of the Rapid Prototyping Capacity within the context of quickly assessing the efficacy of NASA research results and technologies to support the Coastal Management application. An initial RPC project designed to quickly evaluate the utility of moderate-resolution MODIS products for calibrating / validating coastal sediment transport models is also presented.

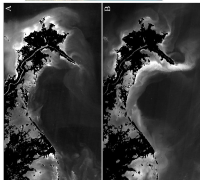
INTRODUCTION

Estuaries, bays, and coastal margins are vital to our nation's economy, transportation, commerce, and homeland security. The health of coastal aquatic systems is largely influenced by the concentration and distribution of suspended sediments in the water column. Suspended sediments directly regulate the amount and quality of light available to support phytoplankton and submerged vegetation production. Suspended sediments also govern the transport and fate of numerous pollutants, including heavy metals and polycyclic aromatic hydrocarbons. The consequences of natural and anthropogenic events within a watershed are often revealed by significant changes in the dynamics of suspended sediments in the receiving aquatic system. Therefore, it is essential that effective monitoring strategies of suspended sediments are developed to manage these important national assets.

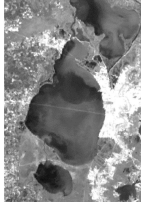


REMOTE SENSING OF SUSPENDED SEDIMENTS

Although the use of remote sensing for mapping suspended sediments is well established (e.g., Miller et al. 2005 (and references therein)), the routine use of remote sensing technologies for coastal aquatic waters is often limited due to the spatial and operating characteristics of space-based instruments. Miller and McKee (2004) demonstrated that NASA's MODIS (Moderate Resolution Imaging Spectroradiometer) 250 m data are well suited for remote sensing of suspended matter in dynamic coastal waters based on the instrument and spacecraft characteristics. However, even the use of MODIS data can be limited due to clouds or high haze conditions. Therefore, are there other data or results that could be used to augment MODIS sediment mapping to provide a more robust monitoring program for decision and policy makers?



Suspended sediments are easily seen in this MODIS true color image taken Nov. 22, 2006.

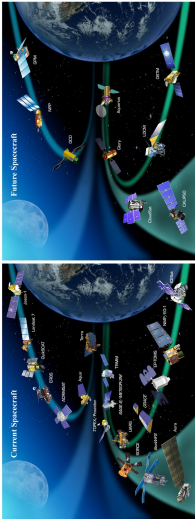


Suspended sediment concentrations measured using MODIS 250 m data.

“RAPID PROTOTYPING”

The NASA Applied Sciences Program (ASP) works to expand the use of NASA research results (i.e., data, models, and products) by coastal environmental managers and policy makers. However, the cycle of research-to-applications-to-operations often takes many years to be realized. Hence, one of NASA's major challenges is to accelerate this process. *Rapid Prototyping* is an approach to quickly assess if select current NASA research results or future NASA data can contribute directly to a decision support system or be used as a decision support tool. Results of Rapid Prototyping exercises provide guidance for future work and partnerships. The process that we employ to determine potential Rapid Prototyping candidates includes answers to:

- 1) What information (e.g., parameter) is required for a Decision Support System or by decision and policy makers?
- 2) Which current or future NASA instruments have the spatial, temporal, and spectral characteristics that can provide the required information?
- 3) Has previous work demonstrated a scientific basis for the new application?
- 4) Who should participate as partners and collaborators?



INITIAL RAPID PROTOTYPING PROJECT (EXPERIMENT)

We conducted an *initial* Rapid Prototyping project to help gain an understanding of the process and procedures required to develop a Rapid Prototyping Capability. After answering the questions above

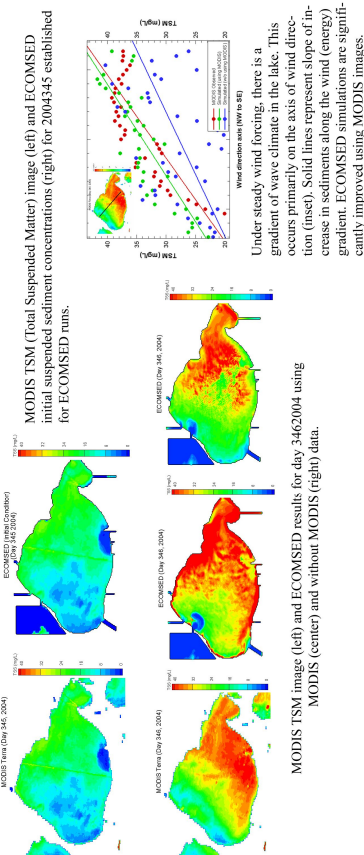
1) Daily, high resolution estimates of suspended sediment concentrations, turbidity, and particle transport/fate.

2) MODIS 250 m and VIIRS (Visible-Infrared Imager Radiometer Suite) 400 m data in the red region of the electromagnetic spectrum.

3) Yes, for example, Miller and McKee (2004), Miller et al. (2005), and Hu et al. (2004).

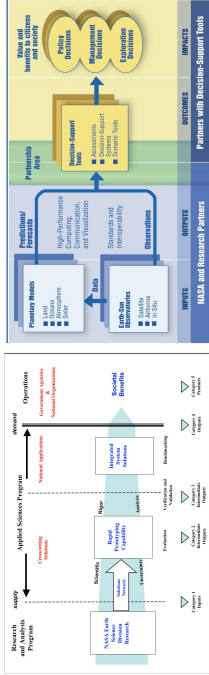
4) Local universities and agencies responsible for monitoring water quality.

a 5 month project was designed to quickly assess whether MODIS 250 m data can be used to set the initial conditions and calibrate a coastal sediment transport model, ECOMSED (Estuarine, Coastal and Ocean Modeling System with Sediments) [Note: full details of this project are presented by poster *OSA41C-0626*], Lake Pontchartrain, LA, a shallow urbanized estuary, was selected as the test case.



RAPID PROTOTYPING CAPABILITY (RPC)

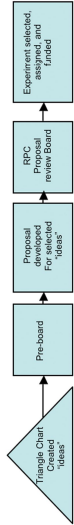
The ASP is using a systems engineering approach to develop and employ a Rapid Prototyping Capability. The RPC will systematically evaluate rapidly prototyped configurations of NASA research results in simulated decision support and/or operations environments to identify configurations that could be considered for further development and testing as an Integrated System Solution (ISS) for an ASP National Application. The RPC will be a distributed system of RPC nodes. A node will contain the computational capabilities (i.e., hardware and software) and access to data, models, and results for rapid assessment of NASA research results.



The RPC is an integral component of the Applied Sciences Program's strategic process to benefit society.

Applied Sciences Program Approach to Integrated System Solutions.

This component of the ASP's Rapid Prototyping effort is managed by the Crosscutting Solutions program element. A Rapid Prototyping project is referred to as a Rapid Prototyping (RP) experiment. The RPC is a collection of models, data simulations for future satellite sensors, data from current satellite systems, computer/network hardware and personnel to provide expertise to “run” experiments. The ASP is developing a process to solicit ideas for RP experiments. The process for experiment concept, selection, and execution is:



CONCLUSION

NASA's Applied Sciences program is developing a Rapid Prototyping Capability to quickly evaluate the potential use of current research results and simulated results from planned missions in national decision support or operational systems that benefit society. An initial Rapid Prototyping project demonstrated the potential that a more robust decision support system for water quality in coastal waters could be developed when MODIS 250 m are used to initialize and calibrate sediment transport models. The RPC philosophy and approach should accelerate and facilitate the use of NASA research results in coastal applications to better protect and sustain these vital national assets.

REFERENCES

Hu, C., Z. Chen, T. D. Clayton, P. Swarenski, J.C. Brock, and F.E. Muller-Karger. 2004. Assessment of estuarine water-quality indicators using MODIS medium-resolution bands: Initial results from Tampa Bay, FL. *Remote Sensing of Environment*, 93, 423-441.

Miller, R.L. and B.A. McKee. 2004. Using MODIS Terra 250 m Imagery to Map Concentrations of Total Suspended Matter in Coastal Waters. *Remote Sensing of Environment*, 93(1-2), 259-266.

Miller, R.L., B.A. McKee and E.J. D'Sa. 2005. Monitoring Bottom Sediment Resuspension and Suspended Sediments in Coastal Waters. In: *Remote Sensing of Coastal Aquatic Environments: Technologies, Techniques and Application*, R.L. Miller, C.E. Del Castillo and B.A. McKee [Eds.], Springer, NY, 259-276.